BROOKHAVEN NATIONAL LABORATORY Safety & Health Services Division INDUSTRIAL HYGIENE GROUP Standard Operating Procedure: Field Procedure	NUMBER **IH62350** REVISION **FINAL Rev 3**
SUBJECT: **HEPA FILTER VACUUM CLEANER TESTING**	DATE **02/23/04** PAGE **1** OF 12

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1.0 <u>Purpose & Scope</u> This procedure provides standardization of the method used for the in-place efficiency testing of HEPA filters on portable vacuum cleaners at BNL. It also ensures the field tester safety from exposure to hazardous substances the vacuum cleaner has been used to collect.

High-efficiency particulate air (HEPA) filters are used on vacuum cleaners as air pollution control. Due to their general reliability and high level of performance, HEPA filters are commonly used to minimize the release of radioactive materials, asbestos, lead, beryllium, or other toxic particulates.

Filters that bear the marking "HEPA" are manufactured to remove $\geq$99.97% of the particles with a mean diameter of 0.3 um from an airstream. The manufacturer warrants the filter to meet these specifications. Upon installation into a vacuum cleaner, BNL policy is to test the installation of the filters. This phase of evaluation is known as "in-place" testing and is designed not only to validate the particle removal efficiency of the HEPA filter but also verify the integrity of associated seal, gasketing, and housing. Criteria for the acceptance of an in-place test is a particle removal efficiency of $\geq$99.97%, i.e. not measurable leakage around the filter and not defects in the filter media.

2.0 Responsibilities

2.1 This procedure will be implemented through the SHSD Industrial Hygiene Group at the request of the owner of the equipment.

2.2 Only persons who have demonstrated the competence by experience and training meeting the criteria set in IH62200 may perform this test.

2.3 The policy of the IH Group is to test equipment in accordance with the frequency requirements established in BNL Standard Based Management System Subject Areas, Standards, and program descriptions or as requested by owners of equipment.

3.0 Definitions

HEPA Filter: A high efficiency particulate filter having a fibrous medium with a particle removal efficiency of at least 99.97% for 0.3-micron particles of Dioctyl Phthalate.

4.0 Prerequisites

4.1 Prior to testing a HEPA filter system, verify the calibration and operability of the test equipment.

4.2 Prior to testing a HEPA filter system, verify the qualification of the personnel conducting the test.

4.3 Prior to testing a HEPA filter system, check with the equipment owner and RCD Facility Support to determine the hazards associated from the material collected in the vacuum cleaner and the precautions needed to prevent exposure to the Tester.

5.0 Precautions

5.1 **Hazard Determination:** The operation of this meter involves exposure to a low hazard chemical (test aerosol) that does not pose a high exposure risk. The meter design does not cause significant ergonomic concerns in routine use. The aerosol

used in the generator would constitute Hazardous Waste if disposed on in bulk. The intended use of the aerosol as a test agent does not constitute a hazardous environmental emission.

5.2 By its very nature, a HEPA test may be done in areas where chemicals or radiation contamination is known or suspected to be present. Inhalation of these contaminants can have significant health effects. These hazards must receive a hazard evaluation by a cognizant ESH professional.

5.3 **Personal Protective Equipment**

5.3.1 Hand: Contact with aerosol liquid should be minimized but dos not pose a significant health risk. Use of this meter in areas of known or suspected chemical or radiological contamination requires the use of disposable gloves. Exam-style, splash gloves are acceptable. Acceptable elastomers are: Nitrile, PVC, and Natural Rubber.

5.3.2 Body: If contact of the body with contaminated surfaces is anticipated, a disposable suit should be used. Acceptable CPC materials include: Tyvek®, KleenGuard®, and cotton. Disposable garments must be discarded as mercury waste if contact with contamination has occurred. If contact with potentially contaminated surfaces is not expected, body covering is optional. However, if personal clothing items become contaminated, they must be surrender for BNL cleaning or disposal.

5.3.3 Foot: If contact of the feet is anticipated with contaminated surface, disposable shoe coverings, boots or booties should be used. Acceptable CPC material include: Tyvek®, KleenGuard®, and rubber. If contact with potentially contaminated surfaces is not expected, shoe coverings are optional. However, if personal shoes become contaminated, they must be surrender for BNL cleaning or disposal.

5.3.4 Respiratory: Under normal use, respiratory protection is not required. If chemical or radiological levels from contamination in the area exceed the OSHA, ACGIH, or DOE standards, respirators are required. A half face or full face APR or PAPR respirator with appropriate cartridge or an air line respirators may be used up to assigned protection factor listed in the BNL's Respiratory Protection Selection and Issuance SOPS.

5.3.5 Eye: Safety Glasses with side shields are required.

5.4 **Prohibitions in testing:**

5.4.1 Do not open the Vacuum cleaner without engineering controls in place to prevent contact with the debris contents of the vacuum.

5.4.2 Do not use Dioctyl Phthalate, (DOP) as the challenge agent.

5.5 **Environmental Management and Waste Disposal:**

5.5.1 The operation converts the Emery 3004 into an aerosol with compressed air. In a test of a passing filter, the aerosol is trapped on the filter. In a system with a leaking filter, some or all of the aerosol is discharged to the environment up the exhaust stack. The concentration of aerosol in the exhaust air has negligible environmental consequences.

5.5.2 The Emery 3004 purchased by the IHG is used until it is all consumed in testing. If needed, the Emery 3004 is to be disposed of as a hazardous liquid via ESWMD.

6.0 Procedure

6.1 **Summary:** Filter efficiency is determined by challenging a HEPA filter with an aerosol and measuring the aerosol concentration both upstream and downstream to calculate the percentage removed by the filter system.

6.2 **Equipment:** Emery® 3004 or alternative (challenge agent)
Aerosol generator
Aerosol detector
Sampling train (Tygon tubing and probes)
Source of clean, medium-pressure (e.g., 50-75 PSI) air

6.3 **Test Protocol**

6.3.1 ***Setup – Nucon® Aerosol Detector***

6.3.1.1 Open detector cover and plug in AC power cord.

6.3.1.2 Turn on detector power switch, allow 5-10 min. warm-up. (Warm-up photometer in the "clear" mode until a stable baseline reading is obtained.)

6.3.1.3 Perform setup procedure as per Sec. 4.0 in the Nucon® Instrument manual.

6.3.1.4 Attach sample collection tubing to detector.

6.3.1.5 Self-calibrate and zero the instrument according to manufacturer's procedures.

6.3.2 ***Setup- Nucon® Generator***

6.3.2.1 Remove aerosol generator from carrying case.

6.3.2.2 Connect air pressure regulator and injection flex pipe.

6.3.2.3 Connect airline hose to regulator. (Attach the compressed air supply line (from house air system, compressed gas cylinder, or portable air compressor) to the generator inlet regulator. The concentration of the challenge aerosol is a function of both the delivered air pressure and the volume of air exhausted through the ventilation system. For typical laboratory fume hood HEPA systems (e.g., air flows of about 1000-5000 ft^3/min), the aerosol generator inlet regulator pressure should be adjusted to about 25 PSI. For significantly larger or smaller systems, the inlet pressure will need to be adjusted with the second state regulator to provide at least a four order-of-magnitude difference between upstream (challenge) and downstream concentrations. Note that manufacturer's specifications limit on the maximum operating pressure for the generator is less than 100 PSI.)

6.3.3 ***Setup- HEPA vacuum cleaner***

6.3.3.1 Prior to testing vacuum cleaner, ensure that RCD FS personnel have checked the vacuum cleaner for surface radiation contamination, any loose dust and debris and tested vacuum cleaner performance (unit is operable).

6.3.3.2 Connect vacuum cleaner hose and power cord

6.3.3.3 Enclose top of vacuum cleaner in a large plastic bag and secure with duct tape.

6.3.3.4 Put 4-6 holes in the bag using a pen or pencil to sample the air inside the bag (vacuum cleaner exhaust). The holes will also prevent the bag from bursting when the unit is turned on.

6.3.4 ***Testing***

6.3.4.1 Place Nucon® Aerosol Detector on cart and perform setup procedure.

6.3.4.2 Connect sampling lines to upstream and downstream ports.

6.3.4.3 Insert upstream probe into pre sampling port of the injection collection tube, which is mounted on the cart. Seal port with duct tape to prevent leaks.

6.3.4.4 Insert flex injection pipe from aerosol generator into injection end of the injection collection tube, (do not seal end).

6.3.4.5 Position the HEPA vacuum cleaner to be tested near the cart and insert vacuum cleaner hose into the output end of the injection collection tube. Seal plastic sleeve around the hose with duct tape.

6.3.4.6 Connect airline supply hose to supplied air source (compressed gas cylinder, house air system, or portable air compressor. Adjust supplied air pressure to the aerosol generator to (40psi-100psi).

6.3.4.7 Turn on HEPA vacuum cleaner to inflate the plastic bag. Run the vacuum cleaner for 1-2 minutes before testing to clear any dust from the motor to exit the bag.

6.3.4.8 Turn on air supply to aerosol generator, adjust air pressure gage on the aerosol generator to approx. 5psi. Injecting the aerosol into the injection collection tube.

6.3.4.9 Observe (pre) upstream reading on detector approx. 60 on the 10 range or 600. Enter data on the In-Place HEPA Filter Test Report form.

6.3.4.10 Place the downstream probe inside the inflated plastic bag to sample air exhausted from the vacuum cleaner. Survey with the probe around the exhaust ports and seals.

6.3.4.11 Measure upstream and downstream aerosol concentrations as follows:

- Measure upstream aerosol concentration
- Return to "clear" mode and re-zero instrument if necessary
- Measure downstream aerosol concentration
- Return to "clear" mode and re-zero instrument if necessary
- Repeat steps in 6.5.4.11 until sequential upstream and downstream readings are within ±5% of their previous readings

6.3.4.12 Record upstream and downstream concentrations. Enter data on the In-Place HEPA Filter Test Report form.

6.3.4.13 Repeat test Step 6.5.4.11 and record on the second entry line on the In-Place HEPA Filter Test Report form.

6.3.5 ***Calculations:***

6.3.5.1 Calculate particle removal efficiency of the filter as follows:

$$\text{Removal Efficiency (\%)} = \frac{C_u - C_d}{C_u} \times 100$$

Where: C_d = downstream aerosol concentration
C_u = upstream aerosol concentration

6.3.5.2 Record data and findings on test report form (see Attachment 9.2).

Except where otherwise specified in the SBMS Subject Area *Exhaust Ventilation* or a system's operating specifications, the acceptable in-place HEPA filter removal efficiency result is >/= 99.97%. Affix results sticker on the unit tested.

6.3.6 ***Recordkeeping:***

6.3.6.1 Remove old HEPA filter test tag. Attach a new HEPA filter test tag on the vacuum cleaner

6.3.6.2 Provide a copy of the HEPA filter test report to the ESH Coordinator, the Facility Support Representative and any other interested parties. The original test report will be retained by SHSD for 30 years.

6.3.7 ***Waste Disposal:*** Discard any un-used or used aerosol test liquid via the policy and procedures of the Waste Management Division. The liquid is a hazardous waste.

7.0 Implementation and training

7.1 *Level 1 Tester* has the highest level of competency in qualified employees. The qualification requirements for this position are defined in the *Implementation and Training* of SOP IH62200.

7.2 *Level 2 Assistant has a* lower level of competency in this method. These employees serve a role as a fully supervised assistant in field-testing. This position often represents a temporary assignment of very short duration (1-3 days). There is no formal qualification requirements necessary for this position as they follow the directions of the Level 1 tester. The role in this SOP is limited to the actions requested and directed by the Level 1 tester.

8.0 References:

8.1 IH SOP IH62300 *In-Place HEPA Filter Testing*

8.2 IH SOP IH62200, HEPA Filter Surveillance Program.

8.3 American National Standards Institute (ANSI). Standard ANSI N510, Testing of Nuclear Air Treatment Systems.

9.0 Attachments

9.1 Figure 1: Diagram of HEPA Test Apparatus
9.2 BNL HEPA Filter Vacuum Cleaner Test Report
9.3 HEPA filter system test results sticker/tag.

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10.0 Documentation

Document Review Tracking Sheet		
PREPARED BY: *(signature/date on file)* **R. Wilson** **Author** **Date 06/19/00**	**REVIEWED BY:** *(signature/date on file)* **R. Selvey** **Group Leader** **Date 06/23/00**	**APPROVED BY:** *(signature/date on file)* **R. Selvey** **IH Group Leader or Division Head** **Date 06/23/00**
Filing Code: **IH62SR.00**	Clone of IH-FP-6.1 that was reviewed by QA **DQAR** **Date**	**Effective Date:** **06/23/00**

Periodic Review Record		
Date of Review	Reviewer Signature and Date	Comments Attached
02/05/01	*(signature/date on file)* Robert Selvey 02/05/01	Added SBMS Banner. Revised Precautions section adding Hazard Assessment, PPE, and Waste Disposal.
03/09/01	*(signature/date on file)* Robert Selvey 03/09/01	Renumbered from IH-FP-6.2 to new system IH623650. Text reviewed, minor format changes made.
02/23/04	*(signature/date on file)* Robert Selvey 02/23/04	Revised to Section 7 Implementation and Training format. Minor revisions of text for agreement with IH62200 and IH62300.

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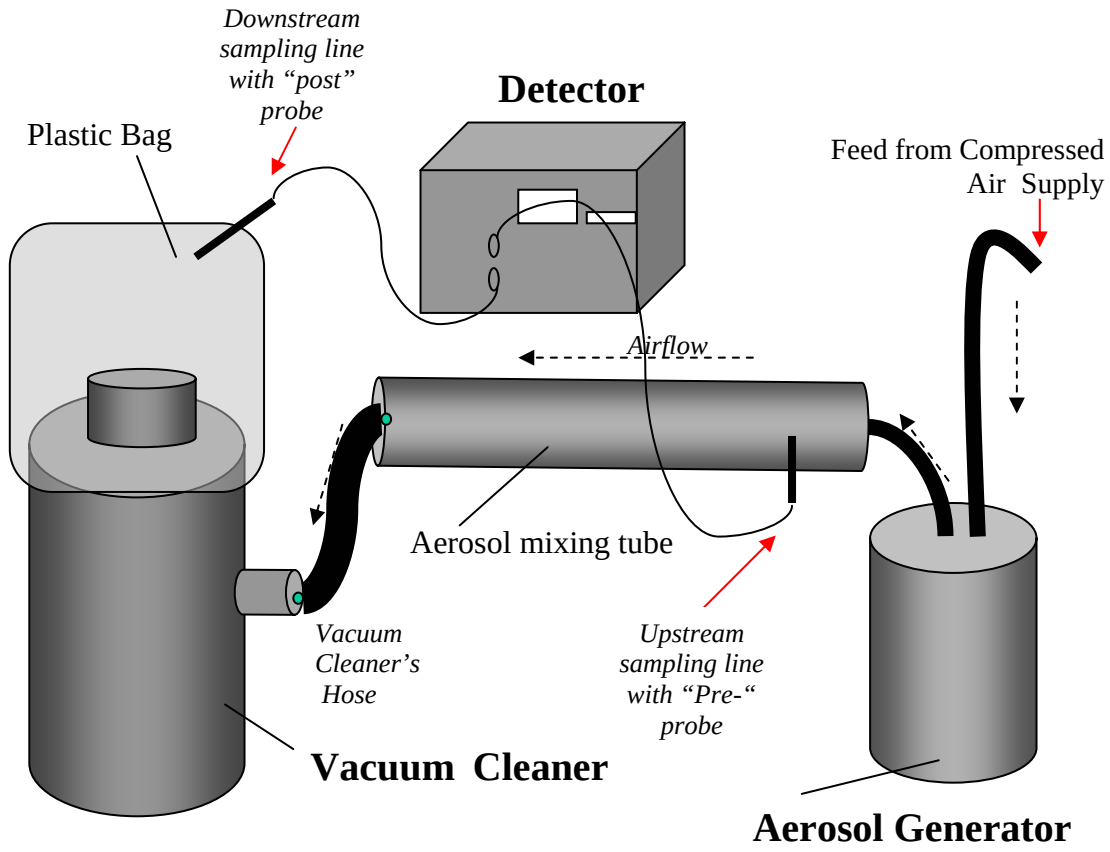
Attachment 9.1
Figure 1: Diagram of HEPA Test Apparatus



IH62350 ATTACHMENT 9.2

Brookhaven National Laboratory
Safety & Health Services Division
Industrial Hygiene Group

HEPA FILTER TEST REPORT
VACUUM CLEANER

Building/Owner: _____ Date of Test: _____

System Type: ___Vacuum Cleaner Technician: _____
___Portable Air Handler

Filter Site: N/A Signature: _____

Aerosol: Emery 3004

Generator: Nucon F1000-SN-10 Serial No. 924SN1005392 _____

Detector: Nucon F1000-DDF Serial No. 924DDF4592 _____

Vacuum Cleaner/Port Air Handler Unit ID	Upstream Reading	Downstream Reading	Removal Efficiency (%)	Comments

Entered into Database: Date:_____ By:_____

IH62350 ATTACHMENT 9.3

Brookhaven National Laboratory
Safety & Health Services Division
Industrial Hygiene Group

HEPA Filter System
Test Results Sticker/Tag

BNL - Safety & Health Services Division - Industrial Hygiene Group

HEPA FILTER TEST: FAILED

Do NOT Use Vacuum Cleaner for Hazardous Substances

Test by: Date:

Unit ID:

Contact: Industrial Hygiene Group at x-3900 SHSD IH62350

BNL - Safety & Health Services Division - Industrial Hygiene Group

HEPA Filter Test: PASSED

Test by: Date:

Unit ID:

Contact: Industrial Hygiene Group at x-3900 SHSD IH62350